What is claimed is:

1. A cryogenic fuel tank comprising:

an exterior surface comprising a skin layer; and

a composite insulation layer affixed to at least a substantial portion of the skin layer, the composite insulating layer including a reinforcing material combined with a non-flammable polymer foam material.

2. The fuel tank of claim 1 wherein the polymer foam material comprises a closed cell foam material.

3. The fuel tank of claim 1 wherein the the foam material is polyisocyanurate foam.

4. The fuel tank of claim 3 wherein the polyisocyanurate foam is a closed cell foam.

5. The fuel tank of claim 1 wherein the polymer foam material comprises polyurethane foam.

6. The fuel tank of claim 5 wherein the polyurethane foam is a closed cell foam.

7. The fuel tank of claim 1 wherein the reinforcing material includes at least one sheet of material added to the polymer foam material.

8. The fuel tank of claim 7 wherein the at least one sheet is a mesh grid sheet of fibers embedded within a layer of the polymer foam material.

9. The fuel tank of claim 8 wherein the at least one sheet is a mesh grid sheet of aramid fiber material.

10. The fuel tank of claim 9 wherein the at least one sheet is a mesh grid sheet having a plurality of interconnected linear fibers.

11. The fuel tank of claim 9 wherein the at least one sheet is a mesh grid having a plurality of interconnected curvilinear fibers.

12. The fuel tank of claim 1 wherein the reinforcing material is selected from the group consisting of nanotubes, nanorods, graphite whiskers, graphite epoxy, poly(*p*-phenylene terephthalamide) aramid fiber, carbon graphite fiber, poly(*m*-phenylene terephthalamide) fiber, silicone nitride fiber, silicone carbide fiber, polyaramid fiber, gel-spun polyethylene fiber, polyarylate fiber, and poly(phenylene sulfide) fiber.

13. The fuel tank of claim 1 wherein the reinforcing material comprises a plurality of discrete strengthening fibers interspersed and embedded within a layer of the polymer foam material.

14. The fuel tank of claim 13 wherein the discrete fibers are selected from the group consisting of silicon carbide fibers, nanotubes, nanorods, carbon graphite whiskers and carbon graphite fibers.

15. The fuel tank of claim 14 wherein the discrete fibers are nanotubes.

16. The fuel tank of claim 15 wherein the nanotubes have diameters ranging from about 1 to about 2 nm and lengths ranging from about 0.1 μm to about to about 50 μm.

17. The fuel tank of claim 16 wherein the polymer foam material is a closed cell foam having a cell size of about 200 μm.

18. The fuel tank of claim 16 wherein a plurality of the nanotubes intersect and are fused to one or more other nanotubes.

19. The fuel tank of claim 14 wherein the discrete fibers are carbon graphite whiskers having a diameter ranging from about 0.1 to about 1 μm and a length ranging from about 5 to about 50 μm.

20. The fuel tank of claim 19 wherein the polymer foam material is a closed cell foam having a cell size of about 200 μm.

21. The fuel tank of claim 14 wherein the discrete fibers are carbon fibers having diameters of less than 8 μm and the polymer foam material is a closed cell foam having a cell size of about 200 μm.

22. A cryogenic fuel tank for attachment to an exterior of an orbiter during launch and ascent, the fuel tank comprising:

a skin layer having an exterior surface; and

a composite insulation layer affixed to at least a substantial portion of the exterior surface of the skin layer, the composite insulating layer including a reinforcing material embedded with a closed cell polyisocyanurate foam,

the reinforcing material being selected from the group consisting of nanotubes, nanorods, graphite whiskers, silicone carbide fiber, poly(*p*-phenylene terephthalamide) aramid fiber mesh, and poly(*m*-phenylene terephthalamide) fiber mesh.

23. The fuel tank of claim 22 wherein reinforcing material consists essentially of the discrete fibers are nanotubes having diameters ranging from about 1 to about 2 nm and lengths ranging from about 0.1 μm to about to about 50 μm and the polyisocyanurate foam is a closed cell foam having a cell size of about 200 μm.

24. The fuel tank of claim 23 wherein a plurality of the nanotubes intersect and are fused to one or more other nanotubes.

25. The fuel tank of claim 22 wherein reinforcing material consists essentially of the discrete fibers are carbon graphite whiskers having a diameter ranging from about 0.1 to about 1 μm and a length ranging from about 5 to about 50 μm and the polyisocyanurate foam is a closed cell foam having a cell size of about 200 μm.

26. The fuel tank of claim 22 wherein the reinforcing material consists essentially of poly(p-phenylene terephthalamide fiber mesh.

27. A method for strengthening an exterior insulation layer on an exterior surface of a skin of a cryogenic fuel tank, the method comprising:

providing a quantity of a non-flammable polymer foam material and a reinforcing material;

combining the polymer foam material and the reinforcing material to form a composite insulating layer; and

affixing the composite insulating layer in an uncured state to at least a substantial portion of the exterior surface of the skin.

28. The method of claim 27 wherein the combining further comprises:

embedding the reinforcing material in the foam material when the foam material is in a liquid state.

29. The method of claim 28 wherein the embedding further comprises:

spraying the exterior surface of the skin of the fuel tank with the foam material to form a first layer of foam material thereon;

placing at least one sheet of the reinforcing material over the first layer of foam material; and

spraying a second layer of foam material on the sheet and first layer.

30. The method of claim 28 wherein embedding further comprises:

adding a plurality of discrete strengthening fibers to the foam material before the foam material is cured and affixed to the exterior surface of the skin.

31. The method of claim 27 wherein the combining and affixing are completed substantially simultaneously.

32. The method of claim 28 further comprising:

adding a foam material layer in a liquid state onto the exterior surface of the skin;

placing a reinforcing material layer on the first foam material layer;

adding another foam material layer in a liquid state onto the first foam material and reinforcing material layers; and

curing the foam material layers.

33. The method of claim 32 wherein the adding further comprise pouring the liquid foam material.

34. The method of claim 32 wherein adding further comprise spraying the liquid foam material.

35. The method of claim 32 wherein the adding, placing and adding are repeated a desired number of times.

36. The method of claim 27 further comprising:

securing at least one reinforcing material layer adjacent the exterior surface of the skin;

adding a foam material layer in the liquid state in such a manner to substantially encapsulate the reinforcing material layer in the foam material layer; and

curing the foam material layer.

37. The method of claim 36 wherein the adding further comprises:

pouring the liquid foam material over the reinforcing material layer and the skin layer.

38. The method of claim 37 wherein the adding further comprises:

spraying the liquid foam layer over the reinforcing material layer and the skin layer.

39. The method of claim 27 wherein the combining further includes adding a sufficient amount of the reinforcing material to a sufficient amount of the polymer foam material so that the composite insulating layer has a compressive strength and a tensile strength sufficient to prevent the composite insulating layer from fracturing and being separated from the fuel tank as a result of thrust imposed on the composite insulating layer during a launch and ascent to space when the fuel tank is attached to a space shuttle orbiter.

40. The method of claim 27 wherein the polymer foam material comprises a closed cell polyisocyanurate foam.

41. The method of claim 40 wherein the reinforcing material is selected from the group consisting of nanotubes, nanorods, graphite whiskers, silicone carbide fiber, poly(*p*-phenylene terephthalamide) aramid fiber mesh, and poly(*m*-phenylene terephthalamide) fiber mesh.

42. The method claim 41 wherein the reinforcing material consists essentially of the discrete fibers are nanotubes having diameters ranging from about 1 to about 2 nm and lengths ranging from about 0.1 μm to about to about 50 μm and the polyisocyanurate foam is a closed cell foam having a cell size of about 200 μm.

43. The method claim 42 wherein a plurality of the nanotubes intersect and are fused to one or more other carbon nanotubes.

44. The method of claim 41 wherein the reinforcing material consists essentially of discrete fibers are carbon graphite whiskers having a diameter ranging from about 0.1 to about 1 μm and a length ranging from about 5 to about 50 μm and the polyisocyanurate foam is a closed cell foam having a cell size of about 200 μm.

45. A space orbiter comprising:

a skin layer comprising an interior surface; and

a composite insulation layer affixed to at least a substantial portion of the skin layer, the composite insulating layer including a reinforcing material combined with a closed cell polyisocyanurate foam,

the reinforcing material being selected from the group consisting of nanotubes, nanorods, graphite whiskers, silicone carbide fiber, poly(*p*-phenylene terephthalamide) aramid fiber mesh, and poly(*m*-phenylene terephthalamide) fiber mesh.